A COMPENDIUM OF ARITHMETIC,

WHEREIN

The Rudiments of that noble Art are made eaſy to the weakeſt Capacity:

To which is added,

The ART of NUMBERING BY NUMBERING RODS,

COMMONLY CALLED

NEPIER's BONES;

BY WHICH

Multiplication, Diviſion, *and* Extracting of Roots *both* Square *and* Cube,

ARE PERFORMED,

By the Help of *Addition* and *Subtraction* only.

By JOHN IMISON. K

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M,DCC,LXXXVII.

ADVERTISEMENT.

THE following Treatiſe is wholly written for the improvement of thoſe perſons who have no previous knowledge in Arithmetic; it is therefore hoped the more enlightened reader will not be offended at the ſimplicity of the manner in which it is performed. As it is chiefly intended as an Introduction, I ſhall only inſert ſuch examples as will eaſily and ſpeedily be attainable; hoping the young beginner will be led by this means to purſue this moſt uſeful and delightful ſcience, until he obtain that ſatisfaction and advantage which will amply recompenſe him for his la-

bours. I ſhall firſt begin with Notation, Addition, Subtraction, Multiplication, Diviſion, *&c. without the uſe of the Rods; and then apply the Rods in thoſe rules where they will be the moſt ſerviceable. By this means, I have not the leaſt doubt but any perſon, with a few hours application, may attain ſuch information as to enable them to anſwer moſt queſtions in vulgar arithmetic.*

ARITHMETIC

IS the art of caſting accounts by numbers, and is compriſed in the following fundamental parts, viz. *Numeration*, *Addition*, *Subtraction*, *Multiplication*, and *Diviſion*; which ought thoroughly to be underſtood, as all the other rules depend entirely on them.

NUMERATION

Is the firſt thing to be conſidered in arithmetic: it ſhews how to expreſs the value of any propoſed number; and

and is composed of the ten following characters, viz.

1. One.
2. Two.
3. Three.
4. Four.
5. Five.
6. Six.
7. Seven.
8. Eight.
9. Nine.
0. Cypher.

It consisteth of two parts:

1. The proper order of placing down figures.

2. The true value of each figure in its place.

Both which are exhibited in the following Table:

1 *Units.*
2 *Tens.*
3 *Hundreds.*
4 *Thousands.*
5 *Tens of thousands.*
6 *Hundreds of thous^ds.*
7 *Millions.*
8 *Tens of millions.*
9 *Hundreds of millions.*
10 *Thousands of millions.*
11 *Tens of thousands of millions.*
12 *Hundreds of thousands of millions.*
13 *Billions.*

13	12	11	10	9	8	7	6	5	4	3	2	1	
												1	One.
											2	1	Twenty-one.
										3	2	1	Three hundred and twenty-one.
									4	3	2	1	Four thousand three hundred and 21.
								5	4	3	2	1	Fifty-four thousand 321.
							6	5	4	3	2	1	Six hundred fifty-four thousand 321.
						7	6	5	4	3	2	1	Seven million 654 thousand 321.
					8	7	6	5	4	3	2	1	Eighty-seven million 654 thousand 321.
				9	8	7	6	5	4	3	2	1	987 million 654 thousand 321.
			1	9	8	7	6	5	4	3	2	1	1 thousand 987 million 654 thous^d 321.
		2	1	9	8	7	6	5	4	3	2	1	21 thousand 987 million 654 thous^d 321.
	3	2	1	9	8	7	6	5	4	3	2	1	321 thousand 987 mill^n 654 thous^d 321.
4	3	2	1	9	8	7	6	5	4	3	2	1	4 billion 321 tho^d 987 mill^n 654 tho^d 321

In the foregoing table you may ſee how each place exceeds the former 10 times, increaſing the value towards the left hand.

The firſt place is the place of units.

The ſecond tens.

The third hundreds.

The fourth thouſands, &c.

The denomination of the firſt three places is hundreds.

Of the ſecond is thouſands.

The third is millions.

The fourth is thouſands of millions.

The fifth is billions, or millions of millions.

In reading the numbers, I would adviſe the learner to exerciſe himſelf in the ſmaller firſt, and ſo proceed to greater by degrees, until he be perfect.

Examples for the Practice of Learners.

Expreſs twenty-five in figures?—25.

Write down one hundred and thirty-ſix?—136.

Write down one thouſand one hundred and one?—1101.

Write down one thouſand one hundred and ten?—1110.

Write down in words 1010?—One thouſand and ten.

Write down in words 40700?—Forty thouſand ſeven hundred.

Write in words 893002?—Eight hundred ninety-three thouſand and two.

Write in figures one million ſix hundred and eighty-four thouſand two hundred and forty-two?—1684242.

What is the value of 4787624?—There being ſeven places of figures in this number, look for 7 on the ſide column of the above table, and againſt it

it is millions, which ſhews that the firſt
figure, 4, is 4 millions,

the 2d,	7,	is 7 hundred thouſand,	Thouſands.
3d,	8,	80 thouſand,	
4th,	7,	7 thouſand,	
5th,	6,	6 hundred,	Hundreds.
6th,	2,	20,	
7th,	4,	4,	

or 4 millions 787 thouſand 624.

Expreſs in figures ſix thouſand nine hundred and twenty-five millions?— Look in the above table for thouſands of millions, and againſt it in the ſide column is the figure 10, which ſhews the number contains ten places of figures.——*Anſwer*, 6925000000.

NOTATION BY ROMAN NUMERICAL LETTERS.

I. One.
II. Two.

III.

III. Three.
IV. Four.
V. Five.
VI. Six.
VII. Seven.
VIII. Eight.
IX. Nine.
X. Ten.
XX. Twenty.
L. Fifty.
C. One hundred.
D. Five hundred.
M. One thousand.

When a leſs numerical letter ſtands before a greater, its value muſt be taken from it; as when I ſtands before V or X, and X before L or C, &c.: thus,

Four.	Nine.	Forty.	Ninety.
IV.	IX.	XL.	XC.

When a leſſer numerical letter ſtands after a greater, it is to be added thereto; thus,

VI.

Six.	Eleven.	Sixty.	One hundred & ten.
VI.	XI.	LX.	CX.

A line drawn over any number lefs than a thoufand fignifies fo many thoufands; as,

Sixty thoufand,	One hundred thoufand.
$\overline{\text{LX}}$.	$\overline{\text{C}}$.

100. C.
200. CC.
300. CCC.
400. CCCC. or CD.
500. D. or IↃ.
600. DC.
700. DCC.
800. DCCC.
900. DCCCC.
1000. M. or CIↃ.
2000. CIↃCIↃ. or MM.
3000. CIↃCIↃCIↃ. or MMM.
5000. IↃↃ.
10000. CCIↃↃ.
50000. IↃↃↃ.
100000. CCCIↃↃↃ. or CM.

500000.

500000.	IↃↃↃↃ.
1000000.	CCCCIↃↃↃↃ. or $\overline{\text{M}}$.
1787.	MDCCLXXXVII. or
	CIↃIↃCCLXXXVII.

ADDITION

Teaches to bring two or more numbers into one ſum, and conſiſts of two parts; ſimple, and compound.

SIMPLE ADDITION

Is the adding together any number of units bearing the ſame name; as, 2 pounds 4 pounds 3 pounds, added together, make 9 pounds.

Add together the three following numbers:

First

	Hundreds.	Tens.	Units.
Firſt	2	2	5
Second	6	3	2
Third	4	2	1
Sum 1	2	7	8

Underneath the figures placed as above draw a line, and, beginning at the bottom of the units' place to the right-hand, ſay, 1 and 2 make 3, and 5 make 8, which ſet down under the line in the units' place; then ſay, 2 and 3 make 5, and 2 more make 7, which ſet down in the ſecond or tens' place; laſtly ſay, 4 and 6 make 10, and 2 more make 12, which ſet down, and the whole ſum or anſwer is 1278.

Having placed units under units, tens under tens, &c. begin with the units, and after adding up every figure in the units' row, carry 1 to the next column for every 10, and ſet down the remainder,

remainder, and ſo on in every row following.

Example I.

A had 480*l.* ſterling, B had 565*l.* and C had 396*l.*—how many pounds were there in the whole?

Set the numbers down in their proper places, thus:

4 8.0 *l.*
5.6 5. *l.*
3 9.6 *l.*

Anſw. 1 4 4 1 pounds.

Say, 6 and 5 make 11, ſet down 1, being 1 above 10, and carry 1 to the next column of figures; 1 that I carry and 9 make 10, dot againſt 9 for 1, and ſay 6 and 8 make 14, dot againſt the 8, and ſet down 4; carry the two dots as 2 to the next row, and ſay 2 and 3 make 5, and 5 make 10, dot and ſet down the 4 above it, and the ſum will be 1441*l.*

N. B.

N. B. The number of tens in each row is known by the number of dots, which greatly eafes the memory, obferving to carry 1 for every dot in each preceding row.

Example II.

William, David, and Samuel had the following legacies left them by their father—how much did he leave them in all?

David had -	1 7.6 3 *l.*	fterling.
Samuel had	6 9.4 *l.*	
William had	1 8.7 0 *l.*	
Anfw.	4 3 2 7 *l.*	

Example III.

A corn-factor had in his granaries, numbered as follows,

N° 1.

		Quarters of corn.
Nº 1.	-	4.1 8.1
2.	-	7 2 9.4
3.	-	2.8.3 6.
4.	-	9.4.8.4
5.	-	7 6 3 1

—how many quarters of corn had he in all his five granaries ?

Answ. 31426.

Example IV.

A certain man travelled fifteen days, the following number of miles each day,

1st day's journey,		4.6.
2d ditto	-	3 9.
3d ditto	-	4.0
4th ditto	-	3 8.
5th ditto	-	2 9.
6th ditto	-	3 6
7th ditto	-	4.9.
8th ditto	-	2 7.
9th ditto	-	4 2
10th ditto	-	4.8.

11th

11th ditto	-	4 6
12th ditto	-	4·9·
13th ditto	-	4 7·
14th ditto	-	3 6.
15th ditto	-	2.8

—how many miles did he travel in all? *Answ*. 600.

Example V.

How many days are there in twelve months, each containing as under?

January	-	3 1
February	-	2 8.
March	- -	3·1
April	- -	3 0
May	- -	3 1
June	- -	3·0
July	- -	3 1
August	- -	3 1
September	-	3 0
October	-	3·1
November	-	3 0
December	-	3 1

Answ. 3 6 5 days.

COMPOUND

COMPOUND ADDITION

Is the adding of ſeveral numbers together having divers denominations, *viz.* Money, weight, meaſure, time, &c.

I ſhall here inſert ſeveral uſeful tables, which may either be learned by heart, or be referred to when occaſion requires.

Table I. *Of Money.*

Pence		Shilling		Pence.
20	is	1	and	8
30	—	2	—	6
40	—	3	—	4
50	—	4	—	2
60	—	5	—	0
70	—	5	—	10
80	—	6	—	8
90	—	7	—	6
100	—	8	—	4
110	—	9	—	2
120	—	10	—	0

Note. In addition of Engliſh money, £. ſtands for pounds, *s*. for ſhillings, *d*. for pence, *qu*. for farthings: from the Latin words, *libra*, a pound; *ſolidus*, a ſhilling; *denarius*, a penny; and *quadrans*, a farthing.

Example I.

Suppoſe I owe to one perſon 2*l*. 4*s*. 9*d*. to another 4*l*. 10*s*. 3*d*. to another 7*l*. 1*s*. 10*d*. and to another 16*l*. 14s. 1*d*. —how much do I owe in the whole?

To find this, place the foregoing ſums in ſuch order that pounds may ſtand under pounds, ſhillings under ſhillings, and pence under pence, with ſtrokes of ſeparation between them, as follows:

	£.		*s*.		*d*.
	2.	=	4	=	9
	4	=	10.	=	3.
	7.	=	1	=	10
	16	=	14	=	1
£.	30	=	10	=	11

Here begin at the ſmalleſt denomination towards the right-hand, and ſay 1 and 10 is 11, and 3 is 14, now becauſe 14 exceeds 12, I place a dot there, and carry 2 the remainder to 9, which make 11, this I place under the line; and carry 1 to the ſhillings, ſaying 1 that I carry and 14 is 15, and 1 is 16, and 10 is 26, now becauſe 26 exceeds 20, I place a dot, and carry 6 the remainder to 4, which make 10, this I alſo place under the line; and carry 1 to the pounds, ſaying 1 that I carry, and 6 is 7, and 7 is 14, I here make a dot, and carry 4 to 4, which make 8, and 2 is 10, I make another dot, place a 0 under the line, and carry 2 for the 2 tens to the next row, ſaying 2 that I carry and 1 make 3, which I alſo place under the line; and the anſwer is, thirty pounds ten ſhillings and eleven pence.

Note. Dotting, as above directed, is the moſt ſure method for thoſe per-

ſons who do not chuſe to burthen their memory, and in adding large ſums it is not ſo liable to miſtakes as counting all the pence, &c. together, and then ſetting down the remainder; but, in order for the learner's practice, I ſhall ſhew one example more, caſt up another way.

Example II.

Suppoſe I have owing to me from ſeveral perſons the following ſums, viz. Mr. A. owes me 5*l*. 4*s*. 6*d*. Mr. B. 7*l*. 11*s*. 9*d*. Mr. C. 4*l*. 7*s*. 5*d*. Mr. D. 7*l*. 8*s*. 4*d*. Mr. E. 8*l*. and Mr. F. 9*l*. 7*s*. 6*d*.—how much is owing to me in the whole?

I place them down in order as follows:

Mr. A.

	£.	s.	d.
Mr. A.	5 =	4 =	6
Mr. B.	7 =	11 =	9
Mr. C.	4 =	7 =	5
Mr. D.	7 =	8 =	4
Mr. E.	8 =	0 =	0
Mr. F.	9 =	7 =	6
Anſw.	£. 41 =	19 =	6

and ſay, 6 and 4 is 10, and 5 is 15, and 9 is 24, and 6 is 30, now 30 pence is 2 ſhillings and 6 pence, wherefore I put the 6 pence under its own rank, and carry 2 for the 2 ſhillings to the column of ſhillings, ſaying 2 that I carry and 7 is 9, and 8 is 17, and 7 is 24, and 11 is 35, and 4 is 39, now 39 ſhillings is 1 pound 19 ſhillings, wherefore I ſet down the 19 ſhillings under its own rank, and carry the 1 pound to the pounds, ſaying 1 that I carry and 9 is 10, and 8 is 18, and 7 is 25, and 4 is 29, and 7 is 36, and 5 is 41,

 which

which being placed under the title of pounds, the whole amount is 41 pounds 19 ſhillings and 6 pence.

ADDITION *of Avoirdupois Weight.*

Table II.

16 drams	make	1	ounce,
16 ounces	-	1	pound,
28 pounds	-	1	quarter,
4 quarters	-	1	hundred weight.

Example.

Having placed your numbers in their true places, as follows:

	Cwt.	qrs.	lbs.	oz.
	36 =	2 =	11 =	8
	14 =	1 =	17 =	5
	64 =	2 =	13 =	10
Anſw.	115 =	2 =	14 =	7

begin

begin with the ounces, and ſay 10 and 5 is 15, and 8 is 23, which is 7 above 1 pound, therefore ſet down 7 under the ounces, and carry 1 to the pounds, ſaying 1 that I carry and 13 is 14, and 17 is 31, and 11 is 42, which is 14 pounds above 1 quarter, therefore I ſet 14 under the pounds, and carry 1 to the quarters, ſaying 1 that I carry and 2 is 3, and 1 is 4, and 2 is 6, which is 2 quarters above 1 hundred weight, therefore ſet 2 under the quarters, and carry 1 to the hundreds, which add together, and the work will appear as before ſtated.

ADDITION *of Troy Weight.*

Table III.

24 grains make 1 pennyweight,
20 pennyweights make 1 ounce,
12 ounces make 1 pound.

Example.

	lbs.		oz.		dwts.		gr.
To	25	=	9	=	22	=	12
Add	12	=	11	=	19	=	20
Anſw.	38	=	10	=	2	=	8

Note.—A pound *avoirdupois* weight is equal to 14 ounces 12 pennyweights *troy*.

ADDITION *of Apothecaries Weight.*

Table IV.

20 grains	make	1 ſcruple,
3 ſcruples	- -	1 dram,
8 drams	- -	1 ounce,
12 ounces	- -	1 pound.

Example.

Example.

	lb.		oz.		dr.		ſcr.		gr.
To	15	=	6	=	3	=	2	=	18
Add	10	=	5	=	2	=	2	=	19
Anſw.	25	=	11	=	6	=	2	=	17

From what has been already ſaid of *Addition*, it will be very eaſy to comprehend the preceding as well as the ſucceeding tables, and apply them as occaſion ſerves.

Table V. *Of Time.*

60 ſeconds make 1 minute,
60 minutes — 1 hour,
24 hours — 1 day,
7 days — 1 week,
4 weeks — 1 month,
13 months 1 day and 6 hours make a *Julian* year,

365

365 days 5 hours 48 minutes and 57 seconds make a *solar* year.

Table VI. *Of Motion, used in geographical calculations.*

60 seconds	make	1	minute,
60 minutes	—	1	degree,
90 degrees	—	1	quadrant,
4 quadrants	—	1	circle.

Table VII. *Of Long Measure.*

3 barley corns	make	1	inch,
12 inches	— —	1	foot,
3 feet	— —	1	yard,
$5\frac{1}{2}$ yards	—	1	perch (or pole)
40 perches	—	1	furlong,
8 furlongs	—	1	(statute) mile,
3 miles	—	1	league.

Table VIII. *Of Square Meaſure.*

144	ſquare inches	make	1 ſquare foot,
9	ſquare feet	—	1 ſquare yard,
$3\frac{1}{4}$	ſquare yards	—	1 ſquare pole,
40	ſquare poles	—	1 ſquare rood,
4	ſquare roods	—	1 ſquare acre,
640	ſquare acres	—	1 ſquare mile.

Table IX. *Of Cubic Meaſure.*

1728	cubic inches	make	1 cubic foot,
27	cubic feet	—	1 cubic yard.

Table X. *Of Cloth Meaſure.*

$2\frac{1}{4}$	inches	make	1 nail,
4	nails	—	1 quarter,
4	quarters	—	1 yard,
5	quarters	—	1 ell Engliſh,
3	quarters	—	1 ell Flemiſh,
6	quarters	—	1 ell French.

Table XI.

Table XI. *Of Wine Meaſure.*

$28\frac{7}{8}$ cubic inches make		1 pint,
2 pints	—	1 quart,
4 quarts	—	1 gallon,
42 gallons	—	1 tierce,
$1\frac{1}{2}$ tierce	—	1 hogſhead,
2 hogſheads	—	1 pipe or butt,
2 pipes or butts	—	1 tun,
84 gallons	—	1 puncheon.

Table XII. *Of Beer and Ale Meaſure.*

$35\frac{1}{4}$ cubic inches make		1 pint,
2 pints	—	1 quart,
4 quarts	—	1 gallon,
$8\frac{1}{2}$ gallons	—	1 firkin,
2 firkins	—	1 kilderkin,
2 kilderkins	—	1 barrel,
$1\frac{1}{2}$ barrels	—	1 butt.

In all parts of England, except London, beer and ale are ſold according to this table, agreeable to a ſtatute of exciſe made in 1689.

Table XIII.

Table XIII. *Of Beer and Ale Meaſure in London.*

35¼ cubic inches make			1 pint,
2 pints	—		1 quart,
4 quarts	—		1 gallon,
9 gallons,	—		1 firkin,
2 firkins,	—		1 kilderkin,
2 kilderkins,	—		1 barrel,
1½ barrels	—		1 hogſhead,
2 hogſheads	—		1 butt.

SUBTRACTION.

By *Subtraction* we find the difference of any two numbers by taking the leſſer from the greater, whereby the difference will appear.

Subtraction is the reverſe of *Addition*; for *that* puts the numbers together,

ther, and *this* takes numbers from each other.

In ſetting down numbers place the greater number uppermoſt, and in ſuch order that units may ſtand under units, tens under tens, hundreds under hundreds, &c. as before in *Addition*; and in caſe you cannot have the lower figure in the upper in ſubtracting, borrow 10, and for every 10 ſo borrowed pay 1 to the next lower place toward the left hand.

Example I.

From 4232 greater number,
Take 2121 leſſer number.

Difference 2111

4232 *Proof.*

After I have drawn a line und[e] the ſum, I begin at the firſt figure [...]
th[...]

the leſſer number toward the right-hand, and ſay 1 from 2 there remains 1, which 1 I place below in the line of difference; then proceeding toward the left-hand, ſay 2 from 3 there remains 1, which alſo place below; then ſay 1 from 2 there remains 1, which place as before; laſtly, ſay 2 from 4 there remains 2, which place in the line, and the difference will be 2111. Add the difference and the leſſer number together, and if theſe two put together make the *proof* or greater number, the ſum is right.

Example II.

Suppoſe a man born in the year 1752 ſhould want to know his age.—

Place the preſent year 1787
And from it take 1752

Anſw. 35 years.

Example III.

Example III.

Suppoſe a man 35 years old ſhould want to know the year in which he was born.

Place the preſent year	1787
And from it ſubtract	35
Anſw. A. D.	1752

Example IV.

I borrowed of Mr. A. 361*l.* and paid him 134*l.* in part—what remains now to pay?

£.
361
134
£. 227

Here I ſay 4 from 1 I cannot, therefore I borrow 10, which makes 11, then 4 from 11 there remains 7, which I place under the line, and carry

carry 1 to the next figure 3, which make 4, then ſay 4 from 6 there remains 2, which place under the line, laſtly I ſay 2 from 3 there remains 1, and the ſum is finiſhed, and the difference is 227*l*.

In ſubtraction of money, place pounds under pounds, ſhillings under ſhillings, &c.; and in caſe you cannot have the under figure in the upper, you muſt borrow 4 in the farthings, 12 in the pence, 20 in the ſhillings, and 10 in the pounds.

Example V.

	£.		s.		d.	q.
From	26	=	10	=	2	$\frac{3}{4}$
Take	20	=	16	=	11	$\frac{1}{2}$
Anſw.	5	=	13	=	3	$\frac{1}{4}$

I begin at the leaſt denomination towards the right-hand, and ſay 2 farthings from 3 farthings there remains

 1 farthing,

1 farthing, which ſet down; then ſay 11 pence from 2 pence I cannot, I therefore borrow 12, and ſay 11 from 14 there remains 3, which ſet down; then carry 1 to 16, which make 17, and ſay 17 from 10 I cannot, I therefore borrow 20, and ſay 17 from 30 there remains 13, which place under; then carry 1 to the 0, and ſay 1 from 6 there remains 5, which place below, and the ſum is finiſhed, and the anſwer or difference is 5*l.* 13*s.* 3*d.* $\frac{1}{4}$.

Examples for Practice.

	£.		s.		d.	q.
From	123	=	14	=	8	$\frac{1}{4}$
Take	98	=	17	=	2	
Anſw.	24	=	17	=	6	$\frac{1}{4}$
Proof	123	=	14	=	8	$\frac{1}{4}$

SUB-

SUBTRACTION *of Avoirdupois Weight.*

	(10) Tons.		(20) cwt.		(4) qrs.		(28) lbs.
From	74	=	13	=	2	=	14
Take	56	=	11	=	1	=	20
Anſw.	18	=	2	=	0	=	22
Proof	74	=	13	=	2	=	14

Note.—The figures above lbs. qrs. cwt. &c. denote how many to borrow when there is occaſion.

SUBTRACTION *of Apothecaries Weight.*

	(10) lbs.	(12) oz.	(8) dr.	(3) ſcr.	(20) gr.
From	12 =	4 =	3 =	0 =	0
Take	8 =	5 =	1 =	1 =	15
Remains	3 =	11 =	1 =	1 =	5

SUBTRACTION *of Liquid Meaſure.*

	(10) Tuns.	(4) hhds.	(63) gal.	(8) pints.
From	60 =	3 =	42 =	4
Take	15 =	3 =	46 =	6
Rem.	44 =	3 =	58 =	6

SUBTRACTION *of Dry Measure.*

	(10) Chal.		(4) qrs.		(8) bush.		(4) pecks.
From	100	=	0	=	0	=	0
Take	54	=	1	=	4	=	1
Rem.	45	=	2	=	3	=	3

SUBTRACTION *of Cloth Measure.*

	(10) Yards.		(4) qrs.		(4) nails.
From	974	=	2	=	1
Take	96	=	3	=	2
Rem.	877	=	2	=	3

MULTIPLICATION.

Multiplication is a rule which performs the work of many additions; for by it any given number may be ſpeedily increaſed to any propoſed number of times.

It likewiſe ſerveth to bring great denominations into leſs, of the ſame value; as, pounds into ſhillings, ſhillings into pence, pence into farthings, &c.

There are three things particularly to be obſerved in *Multiplication*, viz. 1. The *multiplicand*, or number to be multiplied; it is generally the greateſt of the two numbers given. 2. The *multiplier*, or number by which you multiply; and it is generally the leaſt of the two numbers given. 3. The

product

product, which is the result of the multiplication.

Example.

Suppose it is required to increase 9 four times.—Place 4 under 9, in the following manner:

9 *multiplicand*
4 *multiplier*
—
Product 36; that is, 4 times 9 is 36.

Before you can proceed in *Multiplication*, the following Table must be perfectly learnt by heart.

Multiplication

Multiplication Table.

2 times	2	is	4
	3	—	6
	4	—	8
	5	—	10
	6	—	12
	7	—	14
	8	—	16
	9	—	18
	10	—	20
	11	—	22
	12	—	24
3 times	3	is	9
	4	—	12
	5	—	15
	6	—	18
	7	—	21
	8	—	24
	9	—	27
	10	—	30
	11	—	33
	12	—	36
4 times	4	is	16
	5	—	20
	6	—	24
	7	—	28
	8	—	32
	9	—	36
	10	—	40
	11	—	44
	12	—	48
5 times	5	is	25
	6	—	30
	7	—	35

5 times	8	is	40
	9	—	45
	10	—	50
	11	—	55
	12	—	60
6 times	6	is	36
	7	—	42
	8	—	48
	9	—	54
	10	—	60
	11	—	66
	12	—	72
7 times	7	is	49
	8	—	56
	9	—	63
	10	—	70
	11	—	77
	12	—	84
8 times	8	is	64
	9	—	72
	10	—	80
	11	—	88
	12	—	96
9 times	9	is	81
	10	—	90
	11	—	99
	12	—	108
10 times	10	is	100
	11	—	110
	12	—	120
11 times	11	is	121
	12	—	132
12 times	12	is	144

This table is ſo obvious that it needs no explanation.

The wonderful productions ariſing from the placing of numbers are many and ſurpriſing. I ſhall here inſert an inſtance, where 9 figures only may be placed to ſuch advantage, that 5 digits given ſhall conſtitute all the parts of the foregoing table that are abſolutely neceſſary to be inſerted for the more apprehenſive part of readers.

A brief Multiplication Table.

Two of theſe multiply, ſtanding againſt the numbers given.	Two of theſe given to be multiplied, or one to be ſquared.	Two of theſe add, reſpecting the given numbers in the middle.
1	9	40
2	8	30
3	7	20
4	6	10
5	5	0

Example.

Example.

Look for the digits to be multiplied in the middle column; as, ſuppoſe I would know what 8 times 6 make, againſt 8 in the middle column is 30 towards the right-hand, and againſt 6 in the middle column is 10, the ſum of which is 40, and thoſe ſtanding againſt the others in the left-hand column are 2 and 4, which multiplied together make 8, ſo that 8 times 6 is 48.

To ſquare any of the middle numbers, ſuppoſe 7, double 20 which ſtands againſt it on the right ſide, then multiply the figure which ſtands againſt it on the left ſide, and the product will be the ſquare of the number. Thus, 20 doubled is 40, and 3 multiplied by 3 make 9, ſo 7 times 7 is 49.

I ſhall proceed now to the rule of working,

Example

Example I.

How much is 4 times 2243 ?

2243 *multiplicand*
4 *multiplier*

Product 8972

Here I ſay 4 times 3 is 12, which being 2 above 10, I ſet the 2 under the multiplier, and carry 1, and ſay 4 times 4 is 16, and 1 that I carry is 17, therefore I place 7 under the line, and carry 1 to the next, ſaying 4 times 2 is 8, and 1 is 9, which I place under the line, and the product or anſwer is 8972. The ſame product will ariſe by ſetting down 2243 four times; thus,

2243
2243
2243
2243

Product 8972

Example

Example II.

Multiply	1787	*multiplicand*
By	22	*multiplier*
	3574	
	3574	
Product	39314	

Here begin with 2 towards the right-hand, and multiply the multiplicand, as in the firſt example, then begin with the next figure 2 of the multiplier towards the left, and place its product below the firſt, one figure backwards towards the left-hand, as is clearly ſhewn in the ſecond example.

Examples for Practice.

```
Multiply  976
      By   32
         ----
         1952
        2928
        -----
Product 31232
```

```
Multiply  8643
      By  1234
          ----
         34572
        25929
       17286
       8643
      --------
Product 10665462
```

Multiply

Multiply	897
By	98
	7176
	8073
Product	87906

Multiply	6789
By	987
	47523
	54312
	61101
Product	6700743

These laſt examples are ſufficient to convince any learner how tireſome it is to work very large ſums in *multiplication*, and alſo how liable perſons with weak memories are to miſtake.

By

By the *Numbering Rods*, it is almoſt inconceivable how eaſily the moſt difficult queſtion in *multiplication* is performed, as will be ſhewn hereafter.

MULTIPLICATION *of Money*.

	s.		d.
Multiply	13	=	3
By			3

£. 1 = 19 = 9 *Product.*

There is no more difficulty in multiplication of money than in compound numbers; it is only to conſider the value of pence, ſhillings, &c. and carry accordingly.

What do 7 yards of cloth come to at 9*s*. 3*d*. per yard?

Multiply

	s.	d.
Multiply	9 =	3
By		7
£. 3 = 4 =		9 *Product.*

When the quantity exceeds 12, find two numbers in the table which being multiplied together will make the quantity, then multiply the price by either of the numbers, and then that product by the other, and the last product will be the answer.

Example.

What do 18 pair of stockings come to at 4*s*. 6*d*. per pair?

	s.	d.	
	4 =	6	
		3	*the first multiplier*
	13 =	6	*the first product by* 3
		6	*the second multiplier*
£. 4 =	1 =	0	*the last product by* 6.

DIVISION

DIVISION

Is a rule by which we discover how often one number is contained in another; as, if it were asked how often 10 is contained in 100, the answer would be 10 times.

In *division* three principal parts are to be taken notice of, viz. 1. The *dividend*, or number to be divided. 2. The *divisor*, or number by which we divide. 3. The *quotient*, or number proceeding from the other two. But it often happens that there is a fourth number, called a *remainder*, which is always of the same quality with the dividend, and must be less than the divisor, if the work be right.

Division performeth the work of many subtractions, as *multiplication*

does that of many additions, by a few figures, in a ſmall time; which *ſubtraction* would require an incredible deal of time, figures, and paper to effect.

Diviſion is either ſingle or compound.

Single diviſion is when the diviſor conſiſts of one figure only, and the dividend of two at leaſt.—Any thing of this kind is anſwered by the multiplication table; as, if 48 is to be divided by 6, the anſwer will be 8, becauſe 8 times 6 is 48. Here 48 is the dividend, 6 the diviſor, and 8 is the quotient or anſwer.

Compound diviſion is when the dividend conſiſteth of many places or figures, and the diviſor of one or more figures; as, if 365, the days in a year, was to be divided by 7, the days in a week,—365 is the dividend, 7 the diviſor, 52 the quotient, and 1 the remainder.

Diviſor

Dividend

Divisor 7) 365 (52 *Quotient*
35

15
14

1 *Remainder.*

Here place the dividend 365 between two hooks, also place the divisor 7 without the hook towards the left-hand, and seek how often you can have your divisor in the first figure of your dividend, now you find you cannot have it at all in your first figure, therefore you must take the next figure 6, which make 36, and seek how often you can have your divisor in 36, which you will find to be 5 times, place down 5 in your quotient, and say 5 times 7 (your divisor) is 35, which subtract from 36, and there remains 1, then make a dot under 5 the

laſt figure in your dividend, and bring it down to 1 the remainder of your laſt operation, and it makes 15, then ſeek how often you can have your diviſor in 15, which you find to be twice and 1 over, therefore place down 2 in your quotient, and your work is finiſhed.

A general rule for working Diviſion *is comprehended in three particulars, viz.* 1. Seek; 2. Multiply; *and* 3. Subtract.

Examples for Practice.

Divide 288*l.* ſterling amongſt 24 men?

Diviſor *Dividend* *Quotient*

24) 288 (12*l.* for each man.
24

48
48

0 *Remainder.*

Suppoſe

Suppoſe a wheel with 96 teeth was turned round once in 12 hours, and another little wheel, or rather a pinion, of 8 teeth played into the teeth of the great wheel,—how many turns would the little wheel make to 1 turn of the great wheel?

Great wheel
Little wheel 8) 96 (12 turns.
8·
—
16
16
—
0 *Remainder.*

Divide 960 by 24?

24) 960 (40 *Anſwer.*
96·
——
0 *Remainder.*

Divide 64226 by 87?

```
87 ) 64226 ( 738 Answer.
     609..
     ---
      332
      261
      ---
       716
       696
       ---
        20 Remainder.
```

How

How many pounds in 27540 ſhillings ?

Divide by 20, the ſhillings in a pound.

```
20 ) 27540 ( 1377l. Anſwer.
     20
     ——
      75
      60
      ——
      154
      140
      ———
       140
       140
       ———
         0 Remainder.
```

THE

HISTORY, DESCRIPTION, AND USE

OF

NUMBERING RODS,

COMMONLY CALLED

NEPIER's BONES.

THE right hon. *John Nepier*, baron of Merchiſton in Scotland, when he compoſed his admirable *Tables of Logarithms*, finding his calculations ſo laborious in long and tedious *multiplications*, *diviſions*, and *extracting of roots*, as greatly to impede his progreſs, as well as to render the taſk very unpleaſant, at length turned his attention towards contriving ſome help by art which might be of great advantage in expediting his noble enterprize,

terprize. Thinking upon ſeveral methods, he at laſt hit upon the *Numbering Rods,* which he got made of *bones* or *ivory,* from whence aroſe the name of *Nepier's Bones,* the uſes whereof I ſhall in the following treatiſe endeavour to render ſo plain and eaſy that any perſon who can but *add* and *ſubtract* ſhall be made able in a few hours to *multiply* and *divide* any great numbers, and alſo to *extract* both the *ſquare* and *cube roots,* with ſuch facility and expedition as is almoſt inconceivable; for here is no charge at all to the memory, and you ſhall aſſuredly always take your quotient figure in *Diviſion* certain, viz. neither too great nor too little—an inconvenience ſo prejudicial, that I will leave it to the cenſure of thoſe who have found it ſo, to their great loſs of time, and other vexation which it hath put them to.

In the following treatiſe I thought it needleſs to give a minute deſcrip-

tion

tion of the conſtruction of the rods; becauſe it would be only ſpending much time to little purpoſe, as I have conſtructed them in the cheapeſt as well as the moſt convenient manner poſſible.

The rods are divided, by lines acroſs them, into nine equal parts, each of which, except the top diviſion, is ſub-divided by a diagonal line into two others, and forms two half rhomboids or diamond ſquares, and within theſe half rhomboids the figures are placed; in the ſquare at the top there is one of the nine digits, or a cypher. A rod has two digits; one on the front, and another at the back of it. When two of the rods are laid together ſide-ways, the two interior figures in the two half rhomboids muſt be added to-gether, and the exceſs above 10 muſt be carried to the next rhomboid, when any operation is performed.

The Manner of tabulating the Rods.

On the lid of the box of rods you have a fixed rod towards the left hand, with the nine digits in descending order, and at the bottom is a wire to keep the rods even; and on this lid the rods are laid when any queſtion is to be worked.

Suppoſe the number 5864 is to be laid down thereon. From the box of rods take one which has 5 at the top, and lay it on the lid cloſe to the fixed rod; then take a rod with 8 on the top, and place that cloſe to the other; alſo take one with 6 on the top, and place it cloſe to the 8; and laſtly, take one with 4 on the top, and place next to the 6; and you will then have tabulated the number 5864. The lid of the box is called a *Tabulat*; and when the *rods* are laid thereon, we uſually ſay they are *tabulated*.

How to read the Rods when tabulated.

The four rods above-mentioned appear now ſimilar to a glaſs window, every pane thereof repreſenting a diamond form. In reading the figures contained therein, obſerve the following directions.

1. The figures upon the rods are to be read from the right-hand proceeding to the left, which is contrary to the uſual mode in common arithmetic.

2. That in every rhomboid, or diamond, there are either one or two figures, but never more than two.

3. If there be but one figure in the rhomboid, then that figure is to be ſet down alone, *whether a figure or a cypher;* but if there be two figures therein, as moſt commonly happens, add the two together, and ſet down their ſum if under 10, but if it exceeds

ceeds 10, ſet down the overplus, and carry 1 to the next rhomboid.

4. The firſt towards your right-hand, and the laſt towards the fixed rod, are but half-rhomboids, and never have in them more than one figure, but all between them are whole ones, and for the moſt part have two figures in them.

5. If either in rhomboid or half-rhomboid, you find no figures, but cyphers, you muſt not neglect them, but ſet them down as if they were figures.

Theſe rules being rightly underſtood, all that follows will be familiar and eaſy, as will appear by the following examples.

For the illuſtration of the preceding rules, we will make uſe of thoſe *rods* where before tabulated, viz. the number 5864. According to the figure expreſſed by the fixed *rod*, the number will be contained ſo many times the

the rhomboids that are in a right line therewith.

Example I.

Againſt 2 on the fixed rod, beginning at the right hand and proceeding towards the left, you will find 8 in the half-rhomboid,—2 in the next whole rhomboid,—6 and 1 in the next, which add together,—1 in the next,—and 1 in the half-rhomboid which is joined to the fixed *rod*,—in all 11728, or 5864 multiplied by 2.

Example II.

Againſt 5 on the fixed rod, you will find 0 on the right-hand rod in the half-rhomboid,—2 on the next whole rhomboid,—3 on the next,—4 and 5 on the next, which add together,—and on the half-rhomboid toward the fixed rod is the figure 2,—in all 29320, the ſame product as 5864 multiplied by 5.

Example

Example III.

Againſt 9 on the fixed rod, you will find 6 on the half-rhomboid towards the right-hand,—4 and 3 on the next whole rhomboid, which add together, and ſet down 7 to the left of the 6,—in the next rhomboid you will find 5 and 2, which add together, and ſet down 7 to the left of the other 7, —in the next rhomboid you will find 7 and 5, which added together make 12, now the exceſs above 10 muſt be ſet down, which is 2,—and 1 muſt be carried to the 4 in the next half-rhomboid,—and it will be thus read, 52776, the ſame as if 5864 was multiplied 9 times.

From theſe preceding examples, it will not be difficult to read any number when tabulated; but, as a further illuſtration I will tabulate 98765, and ſhew

ſhew the products throughout the 9 digits.

98765 being multiplied by	1	produces	98765
	2		197530
	3		296295
	4		395060
	5		493825
	6		592590
	7		691355
	8		790120
	9		888885

This is ſufficient to give a general idea how the numbers are collected from the rods, and a more particular one may be formed from a little practice, and an attentive conſideration of the propoſed rules. I ſhall here obſerve, before I proceed to the more difficult rules, that every perſon muſt be thoroughly acquainted with *Addition* and *Subtraction*, as they cannot make any progreſs in the rods without theſe rules being previouſly known.

MULTI-

MULTIPLICATION

BY THE RODS.

In multiplying by the *rods*, you are to conſider, as in vulgar arithmetic, three particulars, viz. 1. The *multiplicand*; 2. The *multiplier*; and, 3. The *product*; and alſo, that the product doth contain the multiplicand ſo many times as there are units in the multiplier.

The Rule.

Firſt ſet down upon your paper the multiplicand, and under it the multiplier, draw a line under them, and tabulate your multiplicand; then look what numbers in your rods ſtand againſt the firſt figure towards the right hand in the multiplier, and that num-

ber which you ſhall find ſet down under the line; having ſo done with the firſt figure of your multiplier, do ſo with the reſt, ſetting them down one under another, removing every figure one place more towards the left hand, as in vulgar arithmetic.

Example I.

It is required to multiply 987 by 89.

```
  987
   89
-----
 8883
7896
-----
87843 Answer.
```

1. Set down your multiplicand. 2. Set down your multiplier. 3. Make a line underneath. 4. Tabulate your rods, viz. 987, and begin with 9 in your multiplier, and on the rods you will

will find 8883, which ſet down as above; then take the ſecond number of your multiplier, which is 8, and you will find 7896, which alſo place as above; add the two ſums together, and the produce 87843 is the anſwer.

I ſhall now ſet down ſeveral examples for the practice of learners, omitting any further explanation, as the meaneſt capacity cannot fail of perfectly underſtanding what hath been already ſaid in the preceding rules.

Example II.

Multiply 507605 by 379.

Tabulate	507605	multiplicand
Set down	379	multiplier
Againſt 9 on your rods is	4568445	
Againſt 7 is	3553235	
Againſt 3 is	1522815	
Anſwer	192382295	

Multiply

Example III.

Multiply	9876502			
By	897569			
	88888518	against	9	on rods
	59259012	—	6	—
	49382510	—	5	—
	69135514	—	7	—
	88888518	—	9	—
	79012016	—	8	—
	8864842023638	*Product.*		

DIVISION

BY THE RODS.

In dividing by the rods, you are to consider, as in vulgar arithmetic, three particulars, viz. 1. The *dividend*, or number to be divided; 2. The *diviſor*, or number by which the dividend is divided; and, 3. The *quotient*, which is the number iſſuing from the diviſion of the dividend by the diviſor; and this quotient doth always conſiſt of ſo many units as the number of times the diviſor is contained in the dividend.

THE RULE.

Tabulate the diviſor, which is always the leſſer number of the two given; then ſet down the dividend, and

ſet the diviſor on the left-hand; draw a crooked line on the right-hand of your dividend for the quotient, as in common arithmetic; then look upon your tabulated rods (always) for the number leſs than the number in the firſt figures of your dividend, and the figure which ſtands againſt that number, on the left ſide of your tabulated rods, will be the figure you muſt put in your quotient, and the number leſs on the rods muſt be ſubtracted from the figures in your dividend; and to the remainder bring down another figure, until your diviſion be wholly ended.

Example.

To divide 8595664 by 88, you muſt firſt tabulate 88 your diviſor, and ſet down your diviſor and dividend as follows:

Diviſor

Divisor.	*Dividend.*	*Quotient.*
88)	8595664 (	97678
	792....	
	675	
	616	
	596	
	528	
	686	
	616	
	704	
	704	
	0	

Then look for 859, or the neareſt leſſer number on the rods to 859, and againſt 9 on the fixed rod you find 792; place 9 in your quotient, and 792 under 859 in your dividend, and ſubtract it, and 67 will remain. Then

 bring

bring down the figure 5 from the dividend, and place it after 67, look on the rods for 675, or the neareſt leſſer number to 675, and you find in the 7th place 616; place 7 in your quotient, and 616 under 671, and ſubtract it, and 59 will remain. Then bring down the figure 6 from your dividend, and place it to 59, and look on the rods for 596, or the neareſt leſſer number to 596, and you find in the 6th place 528; place 6 in your quotient, and 528 under 596, and ſubtract it, and 68 will remain. Then bring down from the dividend the other figure 6, and place it to 68, and look on the rods for 686, or the neareſt leſſer number than 686, and in the 7th place you find 616; place 7 in the quotient, and 616 under 686, and ſubtract it, and 70 will remain. Laſtly, bring 4 from the dividend, and place it to 70, and then look on the rods for 704, or the neareſt leſſer number

number to 704, and in the 8th place you find the number itſelf, without any remainder; then place 8 in the quotient. The work is now finiſhed, and you will find that 88 is contained 97678 times in 8595664.

Divide 88558092 by 9876?

```
9876)88558092(8967
     79008···  againſt 8 on the rods
     -----
      95500
      88884     — 9 —
      -----
       66169
       59256    — 6 —
       -----
        69132
        69132   — 7 —
        -----
            0
```

THE

THE RULE OF THREE,

OR GOLDEN RULE.

As this rule is wholly performed by *multiplication* and *division*, I ſhall only give an example or two in the different ſtatement of the queſtions, *viz.* Direct, and Inverſe.

RULE OF THREE DIRECT.

In the *Rule of Three Direct* the fourth number, which is ſought, is to have the ſame proportion to the third as the ſecond number hath to the firſt; as, if the three numbers given were 2, 4, and 8, ſay, as 2 is to 4, ſo is 8 to—what? Multiply 4 by 8, that is, the ſecond number by the third, and the

the product will be 32, and divide by the first number, which is 2, and the quotient will be 16, which is the fourth number in proportion to the third, as the second is to the first; for as 4 the second number contains 2 the first number twice, so 16 the fourth number contains 8 the third number twice also.

Example.

If 4 men eat 2 pecks of corn in 1 week, how many pecks will serve 100 men the same time?

Men.	Pecks.	Men.
4 :	2 :	100

Multiply 2 the second number by 100 the third number, and the product will be 200, which divide by 4 the first number, and the quotient will be 50, and so many pecks will serve 100 men the same time.

INVERSE RULE OF THREE.

In the *Inverſe Rule of Three*, the proportion is not as the firſt to the ſecond; but, as the firſt to the third, ſo is the ſecond to the fourth: as, if the numbers were 3, 4, and 6, ſay as 3 the firſt number is to 6 the third number, ſo is 4 the ſecond number to— what? Multiply 4 the ſecond number by 3 the firſt number, and the product is 12, which divide by 6 the third number, and the quotient will be 2; for as 6 the third number contains 3 the firſt number twice, ſo 4 the ſecond number contains 2 the fourth number twice alſo; and in this conſiſts the difference between the *Direct* and *Inverſe Rule of Three*.

Example.

If 12 men do a piece of work in 8 days, how many men must be employed to do the same piece of work in 2 days?

Days.		Men.		Days.
8	:	12	:	2

Multiply 2 the first number by 12 the second, their product is 96, which divide by 2 the third number, and the quotient will be 48, and so many men will do the work in 2 days; for as 8 days are to 2 days, so are 12 men to 48 men, &c.

THE

The EXTRACTION of ROOTS.

'Tis here the utility of the rods is made manifest, and the tedious questions in extracting of roots are now worked with pleasure, ease, and the greatest certainty. But notwithstanding the use of the rods in extracting of roots is pleasant and easy when attained, yet the attainment is attended with more difficulty than might be imagined, when compared with a few minutes instructions from any person who knows the rules.

OF THE SQUARE ROOT.

In extracting the square root you must, as in common arithmetic, when

you have ſet down your number, make a point under the firſt figure towards your right-hand, and ſo ſucceſſively under every ſecond figure.

Example.

Let it be required to find the ſquare root of 12418576?

Firſt make a point under 6, another under 5, another under 1, and another under 2, under which points draw two lines, in which you muſt place your root, and then your number will ſtand thus:

12418576
 . . . .

Take the rod marked S R, for extracting of the ſquare root, and lay it on the right-hand end of the tabulat, and look in the firſt row or column thereof for

for the neareſt number you can find there leſs than 12 (which is as far as the firſt point in your number reaches) and you will find 9, againſt which, in the third column of your ſquare rod, you will find 3; ſet 3 under the firſt point between the lines, and 9 under the line, and ſubtracting 9 from 12, there will remain 3, which ſet over 12, and your work will ſtand thus:

$$\begin{array}{c} 3 \\ 12418576 \\ \cdot\ \cdot\ \cdot\ \cdot \\ \hline 3 \\ \hline 9 \end{array}$$

Then in the middle column of your ſquare rod, between 9 and 3, there ſtands 6; take therefore one of your rods which hath 6 at the top, and lay it upon your tabulat by the left ſide of your ſquare rod, and ſeek the root of

of 341 for your next point, and the neareſt leſs number on your two rods, and firſt column of your ſquare rod, you will find 325, againſt which, in the laſt column of your ſquare rod, you will find 5, therefore place 5 under your ſecond point, and ſet 325 under 341, and ſubtract it from 341, and there will remain 16, which ſet over head. Then will the ſum appear thus:

16
3
12418576
. . . .

---

3 5

9
325

In the middle column of your ſquare rod, againſt this 5, there ſtands 10; for this 10 you ſhould take a rod

that hath 10 at the top, but as there is no ſuch, take a rod that hath a cypher, and place that between your ſquare rod and rod of 6, and change your rod of 6 for one of 7, and then you will have upon your tabulat one rod of 7, another of 0, and your ſquare rod.

Thus you muſt always do when the number in your middle column exceeds 10.

Then looking upon your ſum, you will find 1685 to extract for your third point, look therefore upon your rods for the neareſt leſs number, which you will find to be 1404, againſt which ſtands 2 in the laſt column of your ſquare rod, ſet 2 between the lines under the third point, and 1404 under 1685, and ſubtracting it from 1685 there will remain 281, which place above, and your ſum will ſtand thus:

```
      281
     16
    3
   12418576
   .  .  . .
   ____ ____
   3 5 2
   _________
   9
   325
     1404
```

The number ſtanding on your ſquare rod, in the middle between 1404 and 2, is 4; take then a rod of 4, and put it between your ſquare rod and your rod of 0; and becauſe 28176 remains upon your ſum for your laſt point to be extracted, look upon your rods for the neareſt number thereto, and you will find the very number itſelf to ſtand againſt the figure 4 on the third column of the ſquare rod; ſet 4 between the lines for your laſt

 point,

point, and ſet 28176 below, and ſubtract it from that above, and 0 will remain, which ſhews 12418576 to be a ſquare number, and the root thereof to be 3524. The work, when finiſhed, will ſtand as under:

```
         0000
         281
        16
       3
Square 12418576
       .  .  .  .
       __________
       3  5  2  4  Root.
       __________
       9
       325
        1404
         28176
```

Caution.

If at any time you look for the remainder (including the two figures in the points) upon your rods, and you cannot

cannot find it there, you muſt place a cypher between the lines, and a rod with o on it adjoining the ſquare rod, and proceed to the next two figures, as by trying the following example will appear:

```
                 90
             54895
           67
       21
     2
   1177162237694
   .  .  .  .  .
   -------------
     3 4 3 0 9 8
   -------------
     9
     256
       2049
           617481
             5489504
```

CUBE ROOT.

There is ſomewhat more difficulty in extracting the *cube* than the *ſquare root*; and, as I before obſerved, a few minutes inſtructions by any perſon who knows the rule, is much more ſatisfactory than the plaineſt inſtruction that can be given in writing; nevertheleſs, I will endeavour to make it as intelligible as poſſible.

Write down the number whoſe cube root you are to extract, and under the firſt figure towards the right hand make a point, and ſo under every third figure towards the left hand, till you come to the end of your number. Under theſe points draw two parallel lines (as you did in extracting the ſquare root), between which

which lines you are to place your root as you proceed. Then, beginning at the figure or figures of the left hand point, and going forwards towards the right hand, extract (by help of the rod for extracting the cube root) their roots; if the true number be not on the rod, take the nearest less, and place the root between the lines, under its points; then subtract its cube from the figures standing before the first point, and note the remainder above.

Example.

Let 22022635627 be a number given whose cube root you desire; set down your number, and point it, and draw two parallel lines under it, and it will stand thus:

22022635627
. . . .

22022635627
. . . .

Look in your cube rod for the neareſt cube root of the figures of your given number, ſtanding before the firſt point towards your left hand, namely 22, which you will find to be 2, ſet 2 between the lines juſt under the firſt point, and its cube (which is 8) ſet under the line, and there will remain 14, which place above, and your work will ſtand thus:

14
22022635627
. . . .

2

8

For

For finding the root belonging to the second point, triple the figure ſtanding under the firſt point (viz. 2), and it is 6, find therefore a rod which hath 6 at the top, and lay it by the ſide of the cubic rod, towards the right hand; then ſquare your firſt point (viz. 2), and triple that ſquare, and it makes 12; find then a rod of 2, and a rod of 1, and place them againſt the left ſide of your cubic rod.

Then, from the rods which lie on the left hand of the cubic rod, and the cubic rod itſelf as far as the ſecond column, find the neareſt leſſer number * than the figures ſtanding before the ſecond point, viz. 14022, and in the ninth place you will find 11529, which, though it is leſs than 14022, yet when the figures on the

* Though ſometimes it happens that the next leſſer number is too large, as in the following example.

rod

rod which lays on the right ſide of the cubic rod are added under the figures of the ninth place of the two laſt columns of the cubic rod, viz. 819, in the following manner, you will find that number too large.

Example.

Number on the ninth place of the two laſt columns of the cubic rod	81,9
Number on the left hand rods - -	11529
Number againſt 1 on the right hand rod	6
Ditto 8 ditto - -	48
Product	16389

Place the number which you find upon the left hand rods leſs than 14022, namely 11529; and in the two laſt columns of your cubic rod you will find in the firſt place 1,1, in the ſecond 4,2, in the third 9,3, in the fourth 16,4, in the fifth 25,5, in the ſixth 36,6, in the ſeventh 49,7, in the

eighth

eighth 64,8, in the ninth 81,9—and this last is the number corresponding to 11529, which place as above, and draw a line between them, and against 1 in the right hand rod you find 6, which place under 1, and in the eighth place you will find 48 on the rod, which also place as in the above example, add them together, and the product is 16389, which cannot be subtracted from 14022, therefore the next less must be taken, in the eighth place, namely 10112, on the left hand rods, which set down, as under:

648	In the eighth place on the two last columns of the cubic rod.
10112	On the left hand rods, and two first columns of the cubic rod.
24	In the 4th place on the right hand rod.
36	In the 6th ditto.
13952	*Product.*

You

You muſt therefore ſubtract 13592 from 14022, and there will remain 70, place 8 for your ſecond point between your lines, and your work will ſtand thus:

```
     70
   14
   22022635627
    .   .  .. .
   ___________
    2  8
   ___________
   8
   13952
```

For finding the root belonging to the third point, triple the two figures ſtanding under the two firſt points, viz. 28, and it is 84; find then a rod of 8, and lay it on againſt the right ſide of the cubic rod, and another rod of 4 cloſe by the ſide of the rod of 8; then ſquare your firſt two points, viz. 28, and it makes 784, triple this ſquare,

square, and it makes 2352; then find four rods, viz. a rod of 2 and place it against the left side of your cubic rod, another of 5 and place it against the 2, another of 3 and place it against the 5, and another of 2 and place it against the 3.

Then from the rods which lie on the left hand of the cubic rod, and the cubic rod itself as far as the second column, find the nearest lesser number than the figures standing before the second point, viz. 70635, and the least number on the rods is 235201, which being too great, the remains must be left to the last point, and a 0 must be placed under the third point.

Lastly, for finding the root belonging to the fourth point, triple the figures standing under the first, second, and third points, namely 280, and the product is 840; place therefore three rods at the right side of your cubic rod,

rod, namely, one of 8, another of 4, and another of 0; then square 280, and it produces 22400, triple this square, and its product is 235200; place then six rods on the left side of your cubic rod, namely, a rod of 0 against the cubic rod, one of 0 against it, one of 2, one of 5, one of 8, and one of 2; and on the left hand rods, and the second column of the cubic rod, choose that number which is next less than the figures belonging to the fourth point, namely 70635627, and in the third place you will find 70560027, set this number down, and place 9,3 above it, thus:

9,3	Number on 3d place of cubic rod.
70560027	on the left hand rods against 3d place.
7560	on the right hand ditto
70635627	*Product.*

Therefore

Therefore ſubtract 7063527 from the figures before your laſt point, and nothing remains, which ſhews that your given number was a perfect cube; place 3 between your lines under your laſt point, your work is finiſhed, and will ſtand thus:

```
                o
         70635
         70
      14
      22022635627
      .   .   .   .
      ______________
        2   8   0   3
      ______________
        8
      13952
                0
         70635627
```

THE END.

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